Claim 1 of the present application is directed to an array of electro-magnetically actuated MEMS devices. Each of the MEMS devices includes: a mirror having a reflective surface; a gimbal structure for movably supporting said mirror about first and second axes; a first coil pair on the mirror for causing selective movement of the mirror about the first axis in the presence of a magnetic field; and a second coil pair on the mirror for causing selective movement of the mirror about the second axis in the presence of a magnetic field. Each of the first and second coil pairs substantially fills the area of the mirror covered by the reflective surface.

Claim 1 is patentable over the cited references for several reasons. First, none of the references, alone or in combination, teaches or suggests an array of MEMS devices, each including a movable mirror. Asada teaches a galvanometer having a single mirror, not an array of mirrors. Laor discloses discrete packaged optical switch units, each having only a single mirror. Neukermans discloses hinges for gyroscopes and accelerometers, and does not disclose any mirrors, much less an array of mirrors.

Second, none of the references, alone or in combination, teaches or suggests a first coil pair and a second coil pair on the mirror for causing selective movement of the mirror about respective axes in the presence of magnetic fields. The Examiner acknowledges that Asada fails to teach two pairs of coils. However, the Examiner states that Laor teaches use of pairs of magnets on a mirror, and that magnets and coils are interchangeable. The Examiner concludes that it would have been obvious to one of ordinary skill in the art to replace the magnets in Laor with pairs of coils, and presumably that Asada could then be modified to include pairs of coils on the mirror.

However, the combination of Asada and Laor does not teach the claimed structure of first and second coil pairs on the mirror. Laor teaches two pairs of magnets mounted on extensions 51 extending from the mirror. There are two additional pairs of magnets on gimbal portions 45. (Fig. 3 and col. 5, lines 34-37). Each

of the pairs of magnets are associated with a single coil 91a-d shown in Figs. 7a-7d. (col. 6, lines 61-64). Thus, if the two pairs of magnets on the mirror extensions were replaced by the coils as suggested by the Examiner, there would be only two coils extending from the mirror. The claimed structure of a first coil pair and a second coil pair on the mirror would thus not be achieved by the substitution suggested by the Examiner.

Furthermore, the substitution would not be obvious. One skilled in the art would not consider using the teachings of Laor in arrays of electro-magnetically actuated mirror devices. Laor teaches using magnets on mirrors. This configuration is not suitable for use in arrays of electro-magnetically actuated devices because magnets on one mirror would likely strongly interact and interfere with magnets on adjacent mirrors in the array. Such "cross-talk" would cause inadvertent movement of neighboring mirrors in an array and would be very undesirable. One skilled in the art would therefore not consider using Laor's teaching in arrays of magnetically actuated devices.

A further feature of Claim 1 not taught or suggested by any of the references is that each of the first and second coil pairs substantially fills the area of the mirror covered by the reflective surface. The Examiner acknowledges that Asada does not teach this feature, but states that Neukermans teaches a coil 151 (Fig. 7a) that substantially fills the area of the mirror covered by the reflective surface. Asada and Neukermans are, however, not properly combinable because there is no suggestion in the references for this combination. Asada discloses one or two coils around a reflective mirror surface. Asada does not in any way suggest or even recognize any need for moving its coils to a position covered by the reflective surface. The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also somehow suggests the desirability of the combination. Asada and Neukermans, however, fail to provide any such suggestions. Thus, the

combination of Asada and Neukermans is improper and fails to make a prima facie showing of obviousness.

In any event, even if the combination is assumed to be proper, it does not teach the claimed feature. As previously mentioned, Neukermans discloses hinges for gyroscopes and accelerometers, and does not disclose or suggest any mirrors. Accordingly, Neukermans can not be said to teach or suggest coil pairs substantially filling the area of the mirror covered by a reflective surface (as there is no such surface). The Examiner acknowledged that Asada does not disclose this feature. Furthermore, the coil 151 of Neukermans, to which the Examiner refers, is located on a gimbal outer frame 101 and not on inner post 109. (col. 7, lines 60-64). Claim 1, by contrast, specifies a mirror supported by a gimbal structure, and pairs of coils on the mirror. Therefore, even if the teachings of Asada and Neukermans could be combined, the combination would, at best, only teach coils on a gimbal frame.

Claim 1 is therefore patentable over the cited references. Claims 2-11 and 73 depend on Claim 1 and are also patentable over the references.

Claim 11 depends on Claim 1 and further recites that the reflective surface is on an opposite side of said mirror from said coil pairs. This feature is not disclosed or suggested by any of the cited references.

Independent Claim 12 is directed to a magnetically actuated mirror array apparatus. None of the cited references teaches or suggests the claimed array of electro-magnetically actuated MEMS devices, each device comprising a mirror. Furthermore, none of the cited references teaches or suggests a first coil pair on the mirror for causing selective movement of said mirror about the first axis in the presence of a magnetic field; and a second coil pair on the mirror for causing selective movement of said mirror about the second axis in the presence of a magnetic field. Additionally, none of the cited references teaches or suggests each of said first and

second coil pairs substantially filling the area of the mirror covered by the reflective surface.

Also, none of the cited references teaches or suggests an array of magnets positioned proximate said array of MEMS devices for applying the magnetic field, each magnet of said array being associated with one or more of said mirror devices. Asada teaches use of a plurality of magnets, but all of these magnets are associated with only a single galvanometer; there is no array of such galvanometers.

Claim 12 and dependent Claims 13-17 and 74 are therefore patentable over the cited references.

Independent Claim 18 is directed to a magnetically actuated mirror array apparatus. None of the cited references teaches of suggests the claimed array of mirror devices generally arranged in a plane. Furthermore, none of the references teaches or suggests an array of magnets generally arranged in a plane proximate and parallel to said plane of said mirror device array, with each magnet being associated with one or more of said mirror devices. Claim 18 and dependent Claims 19-22 are thus patentable over the cited references.

Independent Claim 23 is directed to a MEMS apparatus. None of the cited references teaches or suggests the claimed array of electromagnetically actuated MEMS devices arranged in rows on a substrate. Furthermore, none of the reference teaches or suggests an array of magnets positioned along a plane parallel to said substrate. In addition, none of the references teaches or suggests said array of magnets including magnets along each row of devices having a pole direction parallel to said substrate, and magnets between each row of devices having a pole direction perpendicular to said substrate such that said devices are within a magnetic field produced by said array of magnets. Claim 23 and dependent Claims 24, 25 and 75 are patentable over the references.

Independent Claim 26 is directed to an array of electromagnetically actuated MEMS devices. None of the cited references teaches or suggests the claimed array of MEMS devices arranged in rows and columns. In addition, none of the cited references teaches or suggests each device comprising at least two coils paired together on a single circuit with each coil being wound in opposite directions and being positioned each on a different side of a rotational axis of the device. Also, none of the references teaches or suggests the coils together filling an available surface area. In addition, none of the cited references teaches or suggests the claimed array of magnets of alternating polarities positioned in a plane parallel to a plane containing said array of MEMS devices such that each such device is within a magnetic field containing primarily field lines perpendicular to the plane of said array of MEMS devices. Claim 26 is thus patentable over the cited references.

Independent Claim 27 is directed to a MEMS mirror array package. None of the cited references teaches or suggests the claimed array of magnets. In addition, none of the cited references teaches or suggests the claimed array of electro-magnetically actuated MEMS mirror devices spaced apart from and generally superposed on said array of magnets. Claim 27 and dependent Claims 28-33 are thus patentable over the cited references.

Independent Claim 34 is directed to a magnetically actuated mirror array apparatus. None of the cited references teaches or suggests the claimed array of magnetically actuated mirror devices. Furthermore, none of the cited references teaches or suggests the claimed array of magnets positioned proximate said array of magnetically actuated mirror devices, each magnet in said array of magnets associated with one or more of said mirror devices. In addition, the references do not disclose or suggest a substrate supporting said array of magnetically actuated mirror devices and providing electrical connections to said magnetically actuated devices. Claim 34 is thus patentable over the references.

Independent Claim 35 is directed to a feedback mechanism for determining angular deflection of a mirror about an axis in a magnetically actuated mirror device. The feedback mechanism comprises an excitation coil and a detection circuit for sensing the relative proximity of coils on the mirror to the excitation coil. None of the cited references teaches or suggests these features. The Examiner contends that Neukermans teaches a feedback mechanism (torsion sensors 111 and 115) for determining angular deflection of a mirror about an axis. First, as previously discussed, Neukermans does not disclose or suggest any type of magnetically actuated mirror device; the patent does not relate to mirrors or reflective surfaces. Second, Neukermans's torsion sensors 111 and 115 are simply piezoresistors on the hinges of the device. Neukermans does not disclose or in any way suggest a feedback mechanism comprising an excitation coil and a detection circuit for sensing the relative proximity of coils on the mirror to the excitation coil. Claim 35 and dependent Claims 36-38 are thus patentable over the cited references.

Independent Claim 39 is directed to a feedback mechanism for determining angular deflection of a mirror about an axis in a magnetically actuated MEMS mirror device. None of the references disclose or suggest the claimed mirror device including a pair of actuation coils on the mirror for causing rotation of the mirror about the axis, each actuation coil being on a different side of said axis. In addition, none of the references, including Neukermans, teaches or suggests the claimed feedback mechanism comprising: an excitation coil fixed relative said axis, said excitation coil driven with a high frequency current; and means for detecting a signal from said excitation coil at said actuation coils, said signal having a strength proportional to the relative proximity of said coils to said excitation coil. Claim 39 and dependent Claims 40 and 41 are thus patentable over the cited references.

Independent Claim 42 is directed to a magnetically actuated mirror array apparatus. None of the cited references teach or suggest the claimed array of mirror

devices arranged in a plane. In addition, none of the references teach or suggest each mirror device including means for determining the angular deflection of a mirror about first and second axes. Furthermore, none of the references teach or suggest an array of magnets arranged in a plane proximate and parallel to said plane of said mirror device array, each magnet being associated with one or more of said mirror devices. Claim 42 is thus patentable over the cited references.

Independent Claim 43 is directed to a method for determining the angular deflection of a mirror about an axis in a magnetically actuated mirror device, the mirror device including a pair of coils on the mirror for rotating the mirror about the axis. None of the references, including Neukermans, discloses or suggests the claimed steps of generating a drive signal at a position fixed relative to a structure movably supporting said mirror; detecting an output signal responsive to said drive signal at one of said pair of coils; and determining the angular deflection of said mirror based on the strength of said output signal. As previously discussed, Neukermans only discloses use of torsion sensors 111 and 115 comprising piezoresistors on the hinge of the device. Neukermans does not disclose or suggest the claimed steps. Claim 43 and dependent Claims 44 and 45 are patentable over the cited references.

Independent Claim 56 is directed to an apparatus for determining the angular deflection of a mirror about an axis in a magnetically actuated mirror device. None of the cited references, including Neukermans, teach or suggest: means for generating a drive signal at a position fixed relative to a structure movably supporting said mirror; means for detecting an output signal responsive to said drive signal at one of said pair of coils; and means for determining the angular deflection of said mirror based on the strength of said output signal. Claim 56 and dependent Claims 57 and 58 are patentable over the cited references.

Independent Claim 59 is directed to an electro-magnetically actuated MEMS device. None of the cited references teach or suggest first and second coil pairs on a movable mirror. Furthermore, none of the cited references teach or suggest that each of the first and second coil pairs substantially fills the area of the mirror covered by the reflective surface. Claim 59 and dependent Claims 60-66 are thus patentable over the cited references.

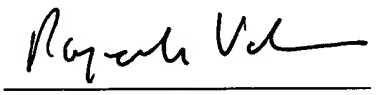
Independent Claim 67 is directed to an electro-magnetically actuated MEMS device. The claimed device features a mirror having a reflective surface; a gimbal frame for movably supporting said mirror about first and second axes; a first coil on the mirror; and a second coil on the gimbal frame, said first and second coils for causing selective movement of said mirror about the first and second axes in the presence of a magnetic field, said first coil substantially filling the area of the mirror covered by the reflective surface. None of the cited references teach or suggest such a structure having the first coil substantially filling the area of the mirror covered by the reflective surface. Claim 67 and dependent Claims 68, 81 and 82 are thus patentable over the cited references.

Independent Claim 69 is directed to an electro-magnetically actuated MEMS mirror array apparatus. None of the cited references teaches or suggests the claimed array of mirror devices. In addition, none of the references discloses or suggest a first and second coil structure wherein the first coil substantially fills the area of the mirror covered by the reflective surface. Furthermore, none of the cited references teaches or suggests an array of magnets positioned proximate said devices for applying the magnetic field, each magnet of said array being associated with one or more of said mirror devices. Claim 69 and dependent Claims 70-72, 83 and 84 are patentable over the cited references.

Claims 1-45, 56-75 and 81-84 are pending in the present application. As the application is now believed to be in condition for allowance, issuance of a Notice of Allowance is respectfully requested.

The Commissioner is hereby authorized to charge any fee deficiency associated with this submission, or credit any overpayment to Deposit Account No. 08-0219.

Respectfully submitted,



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